



Configuring Traffic Shaping on the PA-A3 and PA-A6 ATM Port Adapters

The PA-A3 and PA-A6 ATM port adapters provide the most advanced set of features for ATM traffic management on the Cisco 7200 series routers. This chapter provides details about some of the different service categories supported by the PA-A3 and PA-A6 ATM port adapters for traffic shaping, and provides some guidelines about configuring those service categories.

The purpose of this chapter is to provide you with a combination of design and configuration information to help you make informed decisions about implementing and optimizing traffic shaping on your ATM port adapters. This chapter does not provide information about all applicable configuration procedures or commands that you can configure for a virtual circuit (VC). Therefore, you should also refer to the Cisco IOS software publications applicable to the Cisco IOS software release that you are running on your Cisco 7200 series router.

For more information about configuring ATM on the Cisco 7200 series routers, refer to the *Cisco IOS Wide-Area Networking Configuration Guide* and *Cisco IOS Wide-Area Networking Command Reference* publications available on Cisco.com.

This chapter includes the following sections:

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- [Configuring Real-Time Service Categories, page 5-10](#)
- [Configuring Non-Real-Time Service Categories, page 5-14](#)
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Preparing to Configure Traffic Shaping

This section includes some basic information that you should consider prior to configuring traffic shaping on the PA-A3 and PA-A6 ATM port adapters. Before you begin to configure traffic shaping, be sure you have performed the preparatory tasks recommended in [Chapter 4, “Preparing to Configure ATM Traffic Management and QoS Features.”](#)

Once you have determined your service model and have analyzed your network traffic needs, you need to decide how you are going to implement your VCs and the type of traffic shaping that those VCs should support.

**Note**

As you plan to implement ATM traffic shaping, be aware that Operation, Administration, and Maintenance (OAM) cells are not shaped.

This section includes the following topics to help you begin to configure traffic shaping on your VC:

- [Determining the PVC Configuration Method, page 5-2](#)
- [Configuring VC Classes, page 5-2](#)
- [PVC Configuration Method Examples, page 5-5](#)
- [Choosing a Service Category, page 5-9](#)

Determining the PVC Configuration Method

The PA-A3 and PA-A6 ATM port adapters support both switched virtual circuit (SVC) and permanent virtual circuit (PVC) implementation. This book focuses on PVC configuration and the associated traffic shaping and QoS configuration associated with PVCs.

Before you begin, you should think about how you want to configure your PVCs. You can implement PVC bundles and ranges of PVCs to simplify the configuration of multiple PVCs.

The PA-A3 and PA-A6 ATM port adapters support several different methods of configuring PVCs:

- Single PVCs using ATM VC configuration mode under an interface
- Multiple PVCs in VC bundles using ATM VC bundle configuration mode
- Multiple PVCs in ranges using ATM PVC range or ATM PVC-in-range configuration modes

When you configure PVCs, you also configure certain attributes for those PVCs, including the traffic shaping. To configure traffic shaping and other attributes for a PVC, you can use a couple of methods:

- Use explicit commands to configure traffic shaping directly at the PVC, PVC bundle, or PVC range.
- Define a VC class that contains the explicit traffic shaping commands (and other attributes). Then, attach the VC class where you want the configured attributes to be applied.

You can apply a VC class at many levels, including at an ATM interface or subinterface, an individual PVC, PVC bundle, or PVC range. VC classes are useful when you want to categorize different configurations and apply them to multiple PVCs.

In addition, you can use VC classes to define certain areas of PVC configuration (such as traffic shaping) once, but apply that configuration to multiple PVCs.

Configuring VC Classes

VC classes provide a simplified method of configuring and applying one or more parameters to individual PVCs, PVC bundles, and PVC ranges. To implement VC classes, complete the following steps:

-
- Step 1** Create the VC class.
- From global configuration mode, use the **vc-class atm** command.
- Step 2** Configure the VC parameters.

From ATM VC class configuration mode, configure the VC parameters using one or more of the following commands: **abr**, **broadcast**, **bump**, **cbr**, **encapsulation**, **idle-timeout**, **ilmi manage**, **inarp**, **oam-bundle**, **oam-pvc**, **oam retry**, **oam-svc**, **protocol**, **ubr**, **ubr+**, **vbr-nrt**, and **vbr-rt**.

**Note**

The **ubr+** command was introduced in Cisco IOS Release 11.3 T for SVCs. UBR+ is not applicable to PVCs. However, in releases prior to Cisco IOS Release 12.0(7)T, the command is still available within the CLI for PVC configuration—but it should not be used. If you apply a VC class with the **ubr+** command to a PVC, the Cisco IOS software assigns the UBR class to the PVCs.

Step 3 Apply the VC class.

There are several different commands to apply VC classes depending on where in the configuration you want to apply the VC class. You can apply the VC class at the ATM interface or subinterface, individual PVC or SVC, bundle or bundle member, range of PVCs or individual PVC in a range.

To apply a VC class, use one of the commands shown in [Table 5-1](#).

Table 5-1 List of Commands Used to Apply VC Classes

Command	Configuration Mode	Description
class-bundle	ATM VC bundle (config-atm-bundle)	Applies the attributes defined within a VC class to all members of an ATM VC bundle.
class-int	Interface (config-if) or Subinterface (config-subif)	Applies the attributes defined within a VC class to an ATM main interface or subinterface.
class-range	ATM PVC range (config-if-atm-range)	Applies the attributes defined within a VC class to all members of an ATM VC range.
class-vc	ATM VC (config-if-atm-vc) or ATM VC bundle-member (config-if-atm-member) or ATM PVC-in-range (cfg-if-atm-range-pvc)	Applies the attributes defined within a VC class to an individual PVC, SVC, PVC bundle member, or PVC in a range.

VC Class Configuration Guidelines

When you configure VC classes, consider the following guidelines:

- When you create a VC class for a VC bundle *member*, you can use the following commands to define your parameters: **abr**, **bump**, **cbr**, **precedence**, **protect**, **ubr**, **vbr-nrt**, and **vbr-rt**.
- You cannot use the following commands in ATM VC class configuration mode to configure a VC bundle *member*: **encapsulation**, **protocol**, **inarp**, and **broadcast**. These commands are useful only at the bundle level, not the bundle member level.
- If an SVC command (for example, **idle-timeout** or **oam-svc**) is configured in a VC class, but the VC class is applied on a PVC, the SVC command is ignored. This is also true if a PVC command is applied to an SVC.

Inheritance Rules

If you combine methods of configuring traffic shaping for PVCs—that is, you might configure certain commands directly at the VC and then also implement certain attributes using a VC class—it is important to understand that there is a hierarchy in which the resulting values are set. The parameters that you set in certain levels of configuration take precedence over other levels of configuration where the same values might be set.

Generally speaking, the values of parameters that you configure directly at any level using explicit configuration commands take precedence over the same parameters that you might apply to a VC through the application of a VC class. This allows you to maximize the organization of your configuration so that you can combine common attributes shared by multiple VCs into a VC class; but, it also provides the flexibility for you to override certain attributes directly at the VC level where exceptions might occur.

The PA-A3 and PA-A6 ATM port adapters support the following rules of inheritance:

- Parameters that you set directly for a VC using discrete commands (in ATM VC configuration mode, ATM VC bundle configuration mode, or ATM PVC-in-range configuration mode) supersede VC class parameters applied using the **class-int** command at an ATM main interface or subinterface or using the **class-vc** command.
- Parameters that you set directly for a VC bundle member using discrete commands in ATM VC bundle configuration mode supersede values for the same parameters set for the VC at any other level, including VC class parameters applied using the **class-bundle** command for the entire VC bundle.

VCs within a VC bundle are subject to the following configuration inheritance rules (listed in order of highest precedence):

- VC configuration in ATM VC bundle configuration mode
- VC class configuration in ATM VC class configuration mode
- Subinterface configuration in subinterface configuration mode

- Parameters that you set directly for a VC range member using discrete commands in PVC-in-range configuration mode supersede values for the same parameters set for the VC at any other level, including VC class parameters applied using the **class-range** command for the entire PVC range.
- If you do not explicitly configure an ATM service category (using the **abr**, **cbr**, **vbr-nrt**, **vbr-rt**, **ubr**, or **ubr+** commands) on an ATM PVC, SVC, or VC bundle member, the VC inherits the configuration according to the following hierarchy (listed in order of highest precedence):
 - Configuration within a VC class applied to the PVC or SVC itself.
 - Configuration within a VC class applied to the PVC's or SVC's ATM subinterface.
 - Configuration within a VC class applied to the PVC's or SVC's ATM main interface.
 - Global default configuration: Traffic shaping at the maximum line rate of the PVC or SVC.

PVC Configuration Method Examples

This section provides some examples showing the available configuration methods to configure a PVC:

- [Single PVC Configuration Example, page 5-5](#)
- [VC Bundle Configuration Example, page 5-6](#)
- [VC Range Configuration Example, page 5-6](#)
- [PVC-in-Range Configuration Example, page 5-6](#)
- [VC Class at an ATM Main Interface Configuration Example, page 5-7](#)
- [VC Class at a Single PVC Configuration Example, page 5-7](#)
- [VC Class at an ATM Bundle Configuration Example, page 5-7](#)
- [VC Class at a VC Bundle Member Configuration Example, page 5-8](#)
- [VC Class at a VC Range Configuration Example, page 5-8](#)
- [VC Class at a PVC Within a Range Configuration Example, page 5-9](#)

For more information on PVC configuration and the commands used in these examples, refer to the *Cisco IOS Wide-Area Network Configuration Guide* and *Cisco IOS Wide-Area Network Command Reference*, and the *Cisco IOS Quality of Service Solutions Configuration Guide* and *Cisco IOS Quality of Service Solutions Command Reference* publications.

Single PVC Configuration Example

To create a single PVC, use the **pvc** interface configuration command. From there you can configure traffic shaping and other parameters directly at the VC using explicit commands or by applying a VC class.

The following example shows a single PVC configuration on an ATM main interface with AAL5/MUX encapsulation and the nrt-VBR service category configured directly at the VC:

```
interface atm 2/0
  pvc cisco 1/40
  encapsulation aal5mux ip
  vbr-nrt 100000 50000 20
  exit
```

VC Bundle Configuration Example

To create an ATM PVC bundle, use the **bundle** interface configuration command.

The following example shows creation of a bundle named *new-york*. It specifies the IP address of the subinterface and the router protocol—the router uses Intermediate System to Intermediate System (IS-IS) as an IP routing protocol:

```
interface a1/0.1 multipoint
 ip address 10.0.0.1 255.255.255.0
 ip router isis
 bundle new-york
```

From ATM VC bundle configuration mode, you can configure traffic shaping and other parameters directly at the bundle using explicit commands or by applying a VC class.

VC Range Configuration Example

Another way to configure multiple PVCs is to create a range of PVCs. To create a range of PVCs, use the **range pvc** subinterface configuration command. The **range pvc** command enters you into PVC range configuration mode. From there you can configure traffic shaping and other parameters directly at the VC range using explicit commands or by applying a VC class.

The number of PVCs in a range can be calculated using the following formula:

$$\text{Number of PVCs} = (\text{end-vpi} - \text{start-vpi} + 1) \times (\text{end-vci} - \text{start-vci} + 1).$$

The *start-vpi* argument may be omitted if it is zero. The *end-vpi* argument may be omitted, but if it is omitted, it is assigned the value of *start-vpi*. The *end-vpi* and *end-vci* arguments are always greater than or equal to *start-vpi* and *start-vci* respectively.

When applied to multipoint subinterfaces, the **range pvc** command creates a range of ATM PVCs.

When applied to point-to-point subinterfaces, the **range pvc** command creates a range of PVCs and a corresponding range of point-to-point subinterfaces. For point-to-point subinterfaces, subinterface numbering begins with the subinterface on which the PVC range is configured and increases sequentially through the range.

In the following example, 100 PVCs with virtual channel identifier (VCI) values from 100 to 199 for each virtual path identifier (VPI) value from 0 to 4 are created for a PVC range called *range-pppoa-1*. This configuration creates a total of 500 PVCs in the range. PVC parameters are then configured for the range.

```
interface atm 6/0.110 multipoint
 range range-pppoa-1 pvc 100 4/199
 class-range class-pppoa-1
ubr 1000
 encapsulation aal5snap
 protocol ppp virtual-Template 2
```

PVC-in-Range Configuration Example

To configure an individual PVC within a PVC range, use the **pvc-in-range** PVC range configuration command. From there you can configure traffic shaping and other parameters directly at the VC using explicit commands or by applying a VC class.

The **pvc-in-range** command defines an individual PVC within a PVC range and enables PVC-in-range configuration mode.

In the following example, a PVC called *pppoa* is deactivated. The PVC called *pppoa* is an individual PVC within a configured PVC range:

```
pvc-in-range pppoa 0/130
shutdown
```

VC Class at an ATM Main Interface Configuration Example

To configure traffic shaping using a VC class, use the **vc-class atm** global configuration command to create the class and configure the VC parameters. You can apply VC classes at different levels of the configuration. To apply a VC class at the ATM main interface, use the **class-int** interface configuration command.

In the following example, a class called *classA* is first created and then applied to the ATM main interface 2/0:

```
! The following commands create the class named classA:
vc-class atm classA
ubr 10000
encapsulation aal5mux ip
! The following commands apply classA to ATM main interface 2/0:
interface atm 2/0
class-int classA
```

VC Class at a Single PVC Configuration Example

To apply a VC class at the PVC, use the **class-vc** ATM VC configuration command. The following example shows creation of a class called *classA* and its application to an ATM PVC called *router5*:

```
! The following commands create the class named classA:
vc-class atm classA
ubr 10000
encapsulation aal5mux ip
! The following commands apply classA to an ATM PVC:
interface atm 2/0
pvc router5 1/32
class-vc classA
```

VC Class at an ATM Bundle Configuration Example

To apply a VC class at the PVC bundle, use the **class-bundle** ATM VC bundle configuration command. The following example shows creation of a class called *class1* and its application to the bundle called *bundle1*:

```
! The following commands create the class named class1:
vc-class atm class1
encapsulation aal5snap
broadcast
protocol ip inarp
oam-bundle manage 3
oam 4 3 10
vbr-nrt 100000 50000 20
! The following commands apply class1 to the bundle named bundle1:
bundle bundle1
class-bundle class1
```

Taking into account hierarchy precedence rules, VCs belonging to the *bundle1* bundle will be characterized by these parameters: AAL5SNAP encapsulation, broadcast enabled, use of Inverse Address Resolution Protocol (Inverse ARP) to resolve IP addresses, Operation, Administration, and Maintenance (OAM) enabled, and non-real-time variable bit rate traffic shaping.

This example shows how you can apply VC attributes to all members of a VC bundle using the **class-bundle** command.

VC Class at a VC Bundle Member Configuration Example

You can also apply VC attributes to a particular bundle member using the **class-vc** command, which is shown in this example.

The following example shows creation of a class called *classA* and its application to the bundle member called *vcmember*, which is a member of *bundle1*:

```
! The following commands create the class named classA:
vc-class atm classA
  precedence 6-5
  no bump traffic
  protect group
  bump explicitly 7
  vbr-nrt 20000 10000 32
! The following commands create bundle1, add member named vcmember to
! bundle1, and then apply classA to vcmember:
bundle bundle1
  pvc-bundle vcmember
  class-vc classA
```

Taking into account hierarchy precedence rules, the VC bundle member *vcmember* will be characterized by these parameters:

- It carries traffic whose IP Precedence level is 6 and 5.
- It does not allow other traffic to be bumped onto it. When the VC goes down, its bumped traffic will be redirected to a VC whose IP Precedence level is 7.
- It is a member of the protected group of the bundle. When all members of a protected group go down, the bundle goes down.
- It supports the non-real-time variable bit rate service category.

VC Class at a VC Range Configuration Example

You can also define VC attributes by applying a VC class to a range of PVCs. To apply a VC class to an ATM PVC range, use the **class-range** PVC range configuration command.

The following example shows creation of a class called *classA* and its application to an ATM PVC range called *range-pppoa-1*:

```
! The following commands create the class named classA:
vc-class atm classA
 ubr 10000
  encapsulation aal5snap
! The following commands apply classA to an ATM PVC range:
interface atm 6/0.110 multipoint
  range range-pppoa-1 pvc 0/102 0/199
  class-range classA
```

VC Class at a PVC Within a Range Configuration Example

You can apply a VC class to an individual PVC within a range of PVCs. To apply a VC class to a PVC within a range, use the **class-vc** command in ATM PVC-in-range configuration mode.

The following example shows creation of a class called *classA* and its application to a PVC called *ppoa* within a range of PVCs:

```
! The following commands create the class named classA:
vc-class atm classA
ubr 10000
encapsulation aal5snap
! The following commands apply classA to the ATM PVC named pppoa
! within the range:
interface atm 6/0.110 multipoint
range range-pppoa-1 pvc 0/102 0/199
pvc-in-range pppoa 0/130
class-vc classA
```

Choosing a Service Category

Once you have determined how you want to organize the configuration of your PVCs, as single or multiple PVCs in bundles or ranges, you need to choose the service categories to be supported by those PVCs for traffic shaping.

When determining the type of service category that you are going to support for one or more VCs, you need to determine the type of characteristics that are most important for the applications and types of traffic that those VCs support. You should also consider the traffic contract that you have established with your service provider.

You can reference [Table 5-2](#) for some of the common types of applications that are typically represented by a service category supported on the PA-A3 and PA-A6 ATM port adapters. You can make a comparable selection according to your traffic needs. In addition, when choosing the type of service category for a PVC, it is important to assess whether any of the network applications require bandwidth guarantees or bounds on cell delay and cell loss.

Table 5-2 Common Applications by Service Category

Service Category	Application Examples
ABR	File transfer
CBR (for data, using AAL5)	Audio library, videoconferencing, video on demand
nrt-VBR	Interactive, bursty applications such as airline reservations or banking transactions
rt-VBR	Voice over ATM (VoATM), compressed voice over IP, video conferencing
UBR	File transfer, e-mail, library browsing, fax transmission, Telnet, LAN and remote office interconnections
UBR+ (SVCs only)	Same as UBR, but seek possible minimum bandwidth guarantee

It is important for you to realize that you are not necessarily restricted to a particular type of service category to carry your ATM traffic, nor are you bound to establish the same service categories on both ends of a link. However, each service category uses certain traffic parameters that best define the transmission characteristics of a type of traffic, and will help you to optimize your flow and to meet the requirements of your traffic contract.

In addition, each service category has a default transmission priority associated with it. Therefore, you will achieve the best use of bandwidth and optimize the performance for your traffic if you choose the service category that best represents the type of traffic and applications that will be carried over the PVC. The primary thing to keep in mind is that the ATM service category defines how the ATM network devices and the router treat the cells of the VC with respect to bandwidth guarantees, cell delay, and cell loss.

[Table 5-3](#) provides a list of the traffic parameters by service category that you can reference to determine which parameters provide cell rate guarantees over the network.

Table 5-3 Cell Rate Guarantees by Service Category

Service Category	Traffic Parameter Used to Guarantee Cell Rate
ABR	Non-zero Minimum Cell Rate (MCR) if specified
CBR	PCR
nrt-VBR	SCR
rt-VBR	SCR
UBR	none
UBR+	Non-zero MCR if signalled by the router; applies to switched virtual circuits (SVCs) only on the PA-A3 and PA-A6 ATM port adapters

The remaining sections in this chapter provide information and guidelines for configuring the real-time and non-real-time service categories on the Cisco 7200 series router.

Configuring Real-Time Service Categories

There are two ATM service categories that are designed to support real-time applications, which require low cell delay and cell loss:

- **Constant bit rate (CBR)**—Supports real-time applications that request a static amount of bandwidth that is continuously available for the duration of the connection.
- **Real-time variable bit rate (rt-VBR)**—Supports real-time applications that have bursty transmission characteristics.

The following sections provide an overview of the real-time service categories that are supported on the PA-A3 and PA-A6 ATM port adapters, and include configuration guidelines and examples:

- [Overview of CBR and Real-Time VBR Service Categories, page 5-11](#)
- [Configuring the CBR Service Category on a PVC, page 5-12](#)
- [Configuring the Real-Time VBR Service Category on a PVC, page 5-12](#)

Overview of CBR and Real-Time VBR Service Categories

Both CBR and rt-VBR are typically used for voice and video applications. The rt-VBR service category is frequently used to support Voice over ATM (VoATM). To support these types of applications, both service categories place a limit on the cell delay variation, which is the variability in the arrival of adjacent cells. The primary difference between these two real-time service categories is the way in which the SAR processor services the PVCs with bandwidth.

CBR relies on the regular availability of scheduled time slots with small intercell gaps. PVCs using CBR are characterized by a steady interval of cell transmission over the line. They do not burst cells in clumps. Therefore, unless your PVC is transmitting at the line rate, it will only use some of the total bandwidth that is available.

The CBR service class is designed for ATM VCs needing a static amount of bandwidth that is continuously available for the duration of the active connection. An ATM VC configured as CBR can send cells at the peak cell rate (PCR) at any time and for any duration. It can also send cells at a rate less than the PCR or even emit no cells.

In contrast, rt-VBR makes better use of bandwidth when the traffic is bursty. Like CBR, rt-VBR also relies on the regular availability of scheduled time slots, but also allows the PVC to transmit cells in time slots using an $ICG=1/PCR$ for limited periods of time.

Because of these differences, you do not configure the same traffic parameters for CBR and rt-VBR service categories. You only specify the PCR to implement the CBR service category. The rt-VBR service category implements the PCR, SCR, and MBS traffic parameters (as does the nrt-VBR service category).

CBR for Voice and CBR for Data

ATM defines a protocol stack consisting of three layers. The ATM adaptation layer (AAL) supports the QoS needs of an ATM service class such as CBR or nrt-VBR, and better enables an ATM network to carry different traffic types. AAL1 and AAL5 are the two most commonly used AAL types.

Cisco Systems differentiates between CBR for voice and CBR for data, depending on the AAL type supporting the CBR virtual connection:

- CBR for voice, which includes circuit emulation services (CES) and Voice over ATM (VoATM) applications, uses AAL1. A 1-byte AAL1 header uses time stamps, sequence numbers and other bits to help the ATM network handle ATM-layer defects like cell delay variation, cell misinsertion, and cell loss.
- CBR for data uses AAL5, and the same interface typically does not support CBR for voice. AAL5 adds an 8-byte trailer with a 4-byte cyclic redundancy check (CRC) for detecting errors in a protocol data unit (PDU).

The AAL sublayer functions, which include segmentation and reassembly (SAR), are performed only at the user side of a User-Network Interface (UNI) between a router or Catalyst ATM module and an ATM switch.

Distinguishing CBR and CES

It is important to clarify the differences between CBR and CES. CBR defines an ATM class of user traffic. In contrast, CES defines a method of carrying traffic from non-ATM telephony devices over an ATM cloud. In fact, CES provides an interworking function (IWF) that allows the two protocols to communicate.

To do this, Cisco ATM port adapters that support CES or voice CBR provide two interface types:

- One or more CBR interfaces (typically physical T1s or E1s)—Connects to non-ATM telephony devices, such as a private branch exchange (PBX) or time-division multiplexer (TDM). Use the **interface cbr** command on the PA-A2 to identify the CBR port.
- One ATM interface—Connects to the ATM cloud. Use the **interface atm** command to identify the ATM port.

With CES applications, the source router accepts standard T1 or E1 frames on the CBR port, converts these frames into ATM cells, and transmits the cells out the ATM interface through the ATM cloud. The destination router reassembles the ATM cells and sends them back through the interworking function to a CBR port. The CES specification mandates the transmission of voice traffic on CBR VCs.

To implement CES on the Cisco 7200 series router, use the PA-A2 ATM CES port adapters. To implement CBR for data on the Cisco 7200 series router, use the PA-A3 or PA-A6 ATM port adapters.

Configuring the CBR Service Category on a PVC

As of Cisco IOS Release 12.2, support was added for explicit configuration of CBR on the PA-A3 and PA-A6 ATM port adapters.

To configure a CBR PVC, use the **cbr** ATM VC configuration command as shown in the following example:

```
Router(config)# interface atm 1/0
Router(config-if)# pvc 0/100
Router(config-if-atm-vc)# cbr ?
<1-155000> Peak Cell Rate(PCR) in Kbps
```



Note

CBR support was introduced for the PA-A3 ATM port adapter in the following Cisco IOS software releases: 12.2(5), 12.2(14)S, 12.2(8)T, and 12.2(15)B.

Prior to Cisco IOS Release 12.2, an explicit CLI to configure CBR on the PA-A3 ATM port adapter was not supported. To achieve an equivalent of this real-time service class on the PA-A3 for CBR for data, configure an nrt-VBR PVC and set the PCR and SCR to the same value, while lowering the transmission priority of the VC.



Note

You can also configure the **cbr** command as part of a VC class. For more information, see the [“Configuring VC Classes”](#) section on page 5-2.

Configuring the Real-Time VBR Service Category on a PVC

The rt-VBR service category is intended for real-time applications, such as compressed Voice over IP (VoIP) and video conferencing, that require tightly constrained delays (cell transfer delay, or CTD) and cell delay variation (CDV). In some cases, the cells on a permanent virtual circuit (PVC) experience CDV when two or more VCs share a single ATM interface. You most commonly use the rt-VBR service category to support Voice over ATM (VoATM).

Delay can occur when the SAR processor needs to schedule cells for multiple PVCs, or when the SAR processor must schedule Operation, Administration, and Maintenance (OAM) cells along with servicing cells from one or more PVCs. As a result, the interarrival time between consecutive cells of a connection may vary. This phenomenon is known as *jitter*.

This section includes the following topics:

- [Real-Time VBR Configuration Guidelines, page 5-13](#)
- [Real-Time VBR Configuration Examples, page 5-13](#)

Real-Time VBR Configuration Guidelines

With rt-VBR traffic, you can expect the router to transmit in bursts at a rate that varies with time. To accomplish this, the rt-VBR service category implements the PCR, SCR, and MBS traffic parameters.

When configuring the rt-VBR service category, consider the following guidelines:

- When configuring VoATM, take care when calculating sufficient peak, average, and burst values, and ensure that the PVC can effectively handle the bandwidth for the number of voice calls.
- Use the following formulas as guidelines when establishing the traffic parameters for VoATM:

Traffic Parameter	Guideline for VoATM
PCR	(2 x maximum number of calls) x 16 Kbps
SCR	(1 x maximum number of calls) x 16 Kbps
MBS	4 x maximum number of calls

- The PCR range depends on the line rate of the ATM port adapter.
- In the CLI, the Average Cell Rate represents the SCR and is upwardly bounded by the PCR that you configure. See the [“Real-Time VBR Configuration Examples” section on page 5-13](#).
- There are no default values, and the acceptable ranges vary by the type of ATM port adapter.
- The real-time VBR service category uses the same traffic parameters as the non-real-time VBR service category. For MBS, PCR, and SCR guidelines for both service categories, see the [“MBS Configuration Guidelines” section on page 5-23](#) and the [“PCR and SCR Configuration Guidelines” section on page 5-23](#).

Real-Time VBR Configuration Examples

To configure a rt-VBR PVC, use the **vbr-rt** ATM VC configuration command. The available values for traffic parameters vary by the type of ATM port adapter that you are configuring.



Note

You can also configure the **vbr-rt** command as part of a VC class. For more information, see the [“Configuring VC Classes” section on page 5-2](#).

PA-A3 OC-3 ATM Port Adapter rt-VBR Configuration Example

The following is an example of a rt-VBR configuration on a PA-A3 OC-3 ATM port adapter:

```
Router(config)# interface atm 1/0
Router(config-if)# pvc 0/100
Router(config-if-atm-vc) # vbr-rt ?
<64-155000> Peak Cell Rate(PCR) in Kbps
Router(config-if-atm-vc) # vbr-rt 600 ?
<64-600> Average Cell Rate in Kbps
Router(config-if-atm-vc) # vbr-rt 600 300 ?
<1-64000> Burst cell size in number of cells
Router(config-if-atm-vc) # vbr-rt 600 300 32 ?
```

PA-A3 E3 ATM Port Adapter rt-VBR Configuration Example

The following is an example of a rt-VBR configuration on a PA-A3 E3 ATM port adapter:

```
Router(config-if-atm-vc) # vbr-rt ?
<1-34000> Peak Cell Rate(PCR) in Kbps
Router(config-if-atm-vc) # vbr-rt 600 ?
<1-600> Average Cell Rate in Kbps
Router(config-if-atm-vc) # vbr-rt 600 300 ?
<1-65535> Burst cell size in number of cells
```

PA-A3 T3 ATM Port Adapter rt-VBR Configuration Example

The following is an example of a rt-VBR configuration on a PA-A3 T3 ATM port adapter:

```
Router(config-if-atm-vc) # vbr-rt ?
<1-45000> Peak Cell Rate(PCR) in Kbps
Router(config-if-atm-vc) # vbr-rt 1000 ?
<1-1000> Average Cell Rate in Kbps
Router(config-if-atm-vc) # vbr-rt 1000 1000 ?
<1-65535> Burst cell size in number of cells
```

Configuring Non-Real-Time Service Categories

There are three ATM service categories that are designed to support non-real-time applications, which typically support data services:

- **Available bit rate (ABR)**—Supports non-real-time applications that tolerate high cell delay, and can adapt cell rates according to changing network resource availability to prevent cell loss. The ABR service category is characterized by reactive congestion control, where it uses flow control mechanisms to learn about the network conditions and adjust cell rates accordingly.
- **Non-real time variable bit rate (nrt-VBR)**—Supports non-real-time applications with bursty transmission characteristics that tolerate high cell delay, but require low cell loss.
- **Unspecified bit rate (UBR)**—Supports non-real-time applications that tolerate both high cell delay and cell loss on the network. There are no network service-level guarantees for the UBR service category, and therefore it is a best-effort service.

**Note**

Cisco Systems has also developed a second UBR service category called UBR+, which implements the MCR traffic parameter. UBR+ supports non-real-time applications that tolerate both high cell delay and cell loss on the network, but request a minimum guaranteed cell rate. As with the UBR service category, there are no network service-level guarantees for UBR+. UBR+ is available for SVCs only on the PA-A3 and PA-A6 ATM port adapters.

The following sections provide guidelines and describe how to configure these non-real-time service categories on the Cisco 7200 series router:

- [Configuring the ABR Service Category on a PVC, page 5-15](#)
- [Configuring the Non-Real-Time VBR Service Category on a PVC, page 5-20](#)
- [Configuring the UBR Service Category on a PVC, page 5-26](#)
- [Configuring the UBR+ Service Category—SVCs Only, page 5-27](#)

Configuring the ABR Service Category on a PVC

The ABR service category is designed for VCs that carry file transfer data and other bursty non-real-time traffic that simply requires some minimum amount of bandwidth (specified as a minimum cell rate) to be available while the VC is configured and active. With ABR, the delay or variation in delay from source to destination router can vary and can be a large value, making ABR unsuitable for real-time applications. As discussed previously, the CBR and VBR-rt service categories address applications that require tight boundaries on throughput and delay.

This section includes the following topics:

- [Overview of the ABR Service Category, page 5-15](#)
- [ABR Configuration Guidelines, page 5-19](#)
- [ABR Configuration Example, page 5-20](#)

Overview of the ABR Service Category

ABR allows the ATM port adapter to transmit at a rate that varies with the amount of bandwidth available in the network. When the network is congested and other source devices are transmitting, there is little available bandwidth. However, when the network is not congested, additional bandwidth is available for use by active devices. ABR allows the router to take advantage of this extra bandwidth and increase its transmission rates. To accomplish this, ABR uses resource management (RM) cells to carry information about network congestion. The router uses the information contained in the RM cells to adjust its transmission rates.

An ABR VC binds a source router to a contract with the ATM switch network. As part of this contract, a source router agrees to examine information that indicates whether or not the network is congested and, in turn, adapt the source transmission rate if required. In return, the ATM switch network agrees to drop no more than a maximum number of cells when congestion occurs. The ratio of dropped cells to transmitted cells is known as the *cell loss ratio* (CLR).

Resource Management Cells

RM cells are standard 53-byte ATM cells with the payload type field in the header set to a binary value of 110. Forward RM cells are sent to the destination end-system on the same VC as data cells and at an interval defined by the Number of RM Cells (NRM) parameter. By default, a source ABR device sends one forward RM cell for every 32 data cells.

Table 5-4 describes fields in an RM cell:

Table 5-4 *RM Cell Field Descriptions*

Field	Octet	Bits	Description or Value
Header	1-5	all	ATM header
ID	6	all	Protocol identifier
Reserved	7	1-3	0
RA	7	4	Request Acknowledge; 0 or according to ITU-T, I.371
NI	7	5	Non-Increase: 0—Not congested 1—Non increase
CI	7	6	Congestion Indication: 0—Not congested 1—Congestion indication
BN	7	7	BECN cell: 0—Source generated
DIR	7	8	Direction: 0—Forward (source generated) 1—Backward (destination generated)
ER	8-9	all	Explicit cell rate
CCR	10-11	all	Commitment, concurrency, and recovery; current cell rate; the allowed cell rate by the source
MCR	12-13	all	Minimum cell rate; MCR parameter
QL	14-17	all	Queue length; 0 or according to ITU-T, I.371
SN	18-21	all	Sequence number; 0 or according to ITU-T, I.371
Reserved	22-51	all	6A (hex) for each octet
Reserved	52	3-8	0
CRC-10	53	all	Cyclic redundancy check; according to ATM Forum Traffic Management specifications

ABR Flow Control Mechanisms

ABR supports the following three rate-based methods of communicating congestion information from ATM switches and destination end-systems back to a source device:

- **Binary**—Uses the explicit forward congestion indication (EFCI) bit in ATM data cells to indicate congestion.
- **Relative Rate**—Uses the non-increase (NI) and congestion indication (CI) bits in either forward (to the destination) or backward (to the source) RM cells to indicate presence or absence of congestion. No actual rate is set in any RM cell rate fields.
- **Explicit Rate**—Uses the explicit rate field in backward RM cells to indicate at which rate the source router can transmit. More specifically, with the explicit rate flow control method, a source router places its current transmission rate in the commitment, concurrency, and recovery (CCR) field. Intermediate switches explicitly communicate the rate at which the source is allowed to send at that given moment by placing a value in the explicit rate (ER) field. The source router reads the ER field and adjusts its CCR to match the ER as long as the calculated rate is not less than the minimum cell rate.

These flow control methods are rate-based mechanisms, in which the ATM switch network communicates the rate at which the source can transmit. Rate-based mechanisms contrast with credit-based mechanisms, in which the network communicates the amount of buffer space available for a given VC. The source device transmits only if it knows that the network can buffer the data.

Binary Flow Control

Binary flow control was the first mechanism implemented for ATM networks. ATM switches set the EFCI bit in the headers of forward data cells to indicate congestion. When a destination router receives a data cell with the EFCI bit set, it marks the congestion indication bit in RM cells to indicate congestion and sends the RM cells back to the source.

A standard ATM cell header consists of five bytes. The payload type identifier (PTI) field consists of three bits, each of which defines a different parameter. The first bit indicates whether the cell contains user data or control data. If the cell contains user data, the second bit indicates whether the cell experienced congestion as it moved through the network. This second bit is known as the explicit forward congestion indication (EFCI) bit, and is used in the binary flow control method.

Relative Rate Flow Control

Congestion control schemes operate best when the latency of the feedback path is minimized. Relative rate mode can greatly reduce feedback delays and deliver better performance than the binary mode. Relative rate mode provides the ability for switches to source backward-RM cells to send a congestion indicator rather than relying on the destination end-system to turn around forward RM cells and map the EFCI bit to the CI bit in the backward RM cells.

Explicit Rate Flow Control

Explicit rate ABR is typically deployed in ATM WAN switches, and is used in products like the Cisco 8400 IGX and 8800 MGX ATM switches. Relative rate ABR is more effectively deployed in the campus and is supported by the Cisco Lightstream 1010 and Catalyst 8510 ATM switch routers. The Catalyst 8540 supports EFCI marking only. EFCI is typically used for backward compatibility with legacy ATM switches that support neither explicit rate nor relative rate ABR.

Cisco ATM port adapters implement all three ABR flow-control mechanisms. However, there is no option to select a specific mechanism. Instead, the router adapts to the format and indications received in the incoming RM cells. The mechanism used depends on the configuration of the ATM switches.

ABR Traffic Parameters

Table 5-5 provides information about some of the traffic parameters that the network uses to manage ABR traffic flows.



Note

Only the PCR, MCR, RIF, and RDF traffic parameters are configurable on the Cisco 7200 series router.

Table 5-5 ABR Traffic Parameter Descriptions

ABR Traffic Parameter	Description
Peak Cell Rate (PCR)	Specifies the maximum cell rate at which the source can transmit. This traffic parameter is configurable on the PA-A3 and PA-A6 ATM port adapters.
Minimum Cell Rate (MCR)	Specifies the rate at which a source router can always send. This traffic parameter is configurable on the PA-A3 and PA-A6 ATM port adapters.
Initial Cell Rate (ICR)	Specifies the rate at which a source router should send when the interface first becomes active and when it begins transmitting again after an idle period.
Available or Allowed Cell Rate (ACR)	Specifies the current permitted rate at which the source router can send, based on dynamic feedback from the network.
Rate Increase Factor (RIF)	Specifies the amount by which the transmission rate increases after the source interface receives a resource management (RM) cell with NI and CI set to zero. This traffic parameter is configurable on the PA-A3 and PA-A6 ATM port adapters.
Rate Decrease Factor (RDF)	Specifies the amount by which the transmission rate decreases after the source interface receives an RM cell with the CI bit set to one. This traffic parameter is configurable on the PA-A3 and PA-A6 ATM port adapters.
Number of RM Cells (NRM)	Specifies the number of data cells sent between RM cells. By default, the source sends one RM cell for every 32 data cells. This value is not currently configurable on the PA-A3 and PA-A6 ATM port adapters.
Transient Buffer Exposure (TBE)	Specifies the number of cells that a source can transmit before receiving feedback from the network via a returned RM cell.
Fixed Round Trip Time (FRTT)	Indicates an estimate of the round trip time or the amount of time it takes for an RM cell to be transmitted from the source to the destination and back.

ABR Operation

When permitted, the source device begins transmitting cells at the ACR. The ACR is originally set to the ICR value, and is bounded by the MCR and PCR. The MCR and PCR traffic parameters are established at connection setup.

The router transmits an RM cell prior to the first data cell, and thereafter transmits an RM cell every 32 data cells. Within the RM cell, the router indicates its ACR by placing the ACR value in the CCR field of the RM cell. The ER field reflects the PCR, which is the maximum rate at which the source wants to transmit.

RM cells move forward through the network from the source to the destination. The destination returns the RM cells back to the source, logging information along the way to indicate congestion and rate status. If the destination is incurring internal congestion, it can alter the contents of the RM cell to reflect that congestion. In addition, while the RM cell travels through the network, the switches also can modify the RM cells to set the CI and NI bits of the RM cell.

Upon receipt of an RM cell, a source router first looks at the CI bit:

- If the CI bit is set, the source reduces its ACR by at least $ACR \times RDF$, but no lower than the MCR value.
- If the CI bit is not set, the source increases its ACR by no more than $RIF \times PCR$ to a maximum of the PCR value.

Next, the source looks at the NI bit. If the NI bit equals zero, the source does not increase the ACR.

Finally, if the source router is using explicit rate flow control, it looks at the ER field (after calculating the new ACR based on the CI bit) and adjusts its rate to whichever is lower: the new ACR or the ER.

ABR Configuration Guidelines

When configuring the ABR service category, consider the following guidelines:

- Use the **abr** command to configure the PCR and MCR for the PVC. The PCR is the maximum rate at which the source router is allowed to transmit. The MCR can be set to zero, or it can be used to guarantee a minimum amount of bandwidth to the source router even during periods of congestion.
- Use the **atm abr rate-factor** command to specify the rate at which the ACR is increased or decreased. The default value for both RIF and RDF is 16, which results in a 1/16 factor. We recommend that you use the default values.

Software Guidelines

Support for the ABR service category on the PA-A3 ATM port adapter was introduced in Cisco IOS Release 12.0(4)T and Cisco IOS Release 12.0(5)S. ABR is now available in the Cisco IOS Release 12.1 mainline, Cisco IOS Release 12.1 T and Cisco IOS Release 12.1 E trains.



Note

ABR is not available in the Cisco IOS Release 12.0 mainline.

For the PA-A3 ATM port adapter, we recommend the following minimum Cisco IOS Releases to support ABR:

- Cisco IOS Release 12.0(7)T and later
- Cisco IOS Release 12.0(8)S and later
- Cisco IOS Release 12.1(5) and later

ABR is available in all releases for the PA-A6 ATM port adapter. The PA-A6 ATM port adapter was introduced in Cisco IOS Release 12.2(15)B and Cisco IOS Release 12.2(15)T. It is also supported in Cisco IOS Release 12.3.

ABR service on the PA-A3 and PA-A6 ATM port adapters implement all three modes of rate control. This mode is selected automatically as the PA-A3 or PA-A6 ATM port adapter adapts to the format and indications received in the incoming RM cells.

ABR Configuration Example

To configure a PVC for the ABR service category, use the **abr** ATM VC configuration command as shown in the following example:

```
Router (config)# interface atm 1/0
Router (config-if)# pvc 1/32
Router (config-if-atm-vc)# abr 10000 3000
```

To change the default ABR rate-increase and rate-decrease factors, use the **atm abr rate-factor** interface configuration command as shown in the following example:

```
Router (config)# interface atm 1/0
Router (config-if)# atm abr rate-factor 32 32
```



Note

You can also configure the **abr** command as part of a VC class. For more information, see the “[Configuring VC Classes](#)” section on page 5-2.

Configuring the Non-Real-Time VBR Service Category on a PVC

The non-real-time VBR service category is designed for VCs that carry bursty traffic and are not as sensitive to cell delay, but do not respond well to dropping cells. It is best suited to traffic that can benefit from short bursts up to the PCR, but not large bulk data transfers.

This section includes the following topics:

- [Overview of the Non-Real-Time VBR Service Category, page 5-20](#)
- [Understanding CDVT and Non-Real-Time VBR PVCs, page 5-21](#)
- [Non-Real-Time VBR Configuration Guidelines, page 5-22](#)
- [Non-Real-Time VBR Configuration Examples, page 5-24](#)
- [Verifying a Burst, page 5-25](#)

Overview of the Non-Real-Time VBR Service Category

The PA-A3 and PA-A6 ATM port adapters schedule nrt-VBR PVCs according to the “Leaky Bucket” algorithm. With this algorithm, an ATM VC needs to have a token in the bucket to transmit a cell. The algorithm replenishes tokens in the bucket at the rate of the SCR. If a source is idle and does not transmit for a period of time, tokens accumulate in the bucket. An ATM VC can use the accumulated tokens to burst at the rate of the PCR until the bucket is empty, at which point tokens are again replenished at the rate of the SCR. For more details about the Leaky Bucket algorithm and cell scheduling on the PA-A3 and PA-A6 ATM port adapters, see the “[GCRA \(Leaky Bucket\) on the PA-A3 and PA-A6 ATM Port Adapters](#)” section on page 2-28 and the “[Scheduling on the PA-A3 and PA-A6 ATM Port Adapters](#)” section on page 2-29.

It is important to understand that the PCR is a temporary burst. You derive the duration at which the VC can send at the PCR from the MBS. This translates to a “time on the wire.”

Because the PCR burst is temporary, configure a VC for nrt-VBR if your traffic is bursty and can benefit from the short bursts at the PCR. Otherwise, if your traffic pattern consists of bulk data transfers, the PCR brings virtually no benefit. The reason is that to burst at the PCR, the ATM VC must send for some duration below the SCR.

How Bursting Works—Some Examples

This section describes some examples that show how bursting works and when it is most useful. To best understand these examples, it is helpful for you to understand how the GCRA works. For details about the GCRA, see the [“GCRA \(Leaky Bucket\) on the PA-A3 and PA-A6 ATM Port Adapters”](#) section on page 2-28.

How PCR Bursts Reduce Latency

To begin, assume that you need to transmit interactive traffic that consists of one 1500-byte packet (12000 bits) every second for a total of 12 Kbps. (Ignore ATM overhead in this example.) Configure nrt-VBR on the VC using the following values for the traffic parameters:

- PCR = 800 Kbps
- SCR = 64 Kbps
- MBS = 32 cells

A PCR of 800 Kbps means the first packet is sent in 15 microseconds (12-Kb packet / 800-Kbps PCR). It then takes 187.5 milliseconds (12000-byte packet / 64000-bps SCR) for the token bucket to replenish. The next packet is sent in 15 microseconds.

This example illustrates how PCR bursts reduce latency. Without the PCR, on a VC with only an SCR of 64 Kbps, it would take 187.5 milliseconds to send the first and the second packet.

Bursting and Large File Transfers

This example demonstrates how bursting has little benefit for large file transfers. In this example, use the same traffic parameters as in the previous example and assume that you need to transmit a large file.

Some applications, such as certain video devices, send very large IP packets up to 64 KB. In the previous example, the MBS value matches the size of a single 1500-byte packet. Using the 64-KB packet size, only the first packet is likely sent at the PCR. The average transfer rate will peak at the SCR because the tokens cannot accumulate. Therefore, nrt-VBR bursting offers little benefit for large file transfers.

When large packets exceed the maximum transmission unit (MTU) of the link, such as with a 64-KB packet, it can be useful to send the entire packet as a burst. In these cases, you might want to specify an MBS that accommodates the entire packet. In the example of a 64-KB packet, you should specify an MBS of 1334 cells (64 KB / 48 payload bytes per cell).

Understanding CDVT and Non-Real-Time VBR PVCs

Cell delay variation tolerance (CDVT) is a traffic parameter supported by ATM switches that is closely related to the performance of nrt-VBR PVCs over the network. CDVT establishes a tolerance level on the network switch to ATM interfaces whose PVCs temporarily exceed their traffic contract and aggressively send cells (back-to-back or very closely spaced) over the network. CDVT basically implements a “forgiveness factor” (measured in seconds) for PVCs that exceed the parameters of their traffic contract and it delays implementation of a Usage Parameter Control (UPC) penalty for the PVC.

UPC is the policing mechanism used by switches to control traffic contract violations on the network. UPC applies a mathematical formula to determine whether the traffic being sent by a router on a VC complies with the contract. Providers typically implement UPC policing on the first switch into the network at a point referred to as the User-Network Interface (UNI).

The per-VC UPC policy on Cisco ATM switches (such as the Cisco Catalyst 8500 or Cisco LightStream1010) specifies one of three actions to take with cells that it deems noncompliant:

- Drop the cells.
- Tag the cells by setting the Cell Loss Priority (CLP) bit in the ATM header.
- Pass the cells.

By default, UPC passes any noncompliant cells.

Here is a typical example of a set of rules that a UPC policy enforces at the ATM switch for a nrt-VBR VC:

- For cells that the switch receives that are at or below the SCR, the switch transmits those cells unchanged through the network.
- For cell bursts that the switch receives at rates above the SCR but below the PCR, the switch transmits the cells unchanged for burst sizes smaller than the MBS.
- For cells that the switch receives that are above the PCR and are deemed noncompliant, the switch either tags or discards the cells according to the configured UPC action on the switch.
- For cell bursts up to the PCR that exceed the MBS number of cells and are deemed noncompliant by the switch, the switch either tags or discards the cells according to the configured UPC action on the switch.

Non-Real-Time VBR Configuration Guidelines

This section provides guidelines for configuring the traffic parameters associated with the nrt-VBR service category. [Table 5-6](#) provides a description of the traffic parameters that the network uses to manage nrt-VBR traffic flows.

Table 5-6 Non-Real-Time VBR Traffic Parameter Descriptions

NRT-VBR Traffic Parameter	Description
Maximum Burst Size (MBS)	Specifies the number of cells that can be transmitted at the PCR. Although MBS is specified as a number of cells, it translates to an amount of time, or a duration at which the router sends at PCR.
Peak Cell Rate (PCR)	Specifies the maximum rate at which you expect to transmit cells.
Sustainable Cell Rate (SCR)	Specifies the rate at which you expect to continuously transmit cells.

MBS Configuration Guidelines

When configuring MBS, specify a number of cells that accommodates the typical packet size you expect for bursty traffic. Consider the MBS along with PCR as a means of reducing latency, not increasing bandwidth.

To appropriately configure the MBS, you need to understand cell times. You should understand how the MBS value translates to a PCR duration when provisioning nrt-VBR VCs. For example, recall the formula for calculating the cell time over a DS-1 link:

$$1 \text{ cell} / 3622 \text{ cells per second} = 276.04 \text{ microseconds per ATM cell}$$

On a DS-1 link, an MBS value of 100 equates to a PCR duration of 2.8 milliseconds.

For more information about cell rates supported by other types of ATM interfaces, see [Table 2-7 on page 2-26](#).

You can also calculate this time in seconds using the following formula:

$$T = (\text{burst cells} \times 424 \text{ bits per cell}) / (\text{PCR} - \text{SCR})$$

MBS yields the duration at which the router sends at the PCR. MBS accommodates temporary bursts or short spikes in the traffic pattern. An MBS of 100 cells allows a burst of three MTU-size Ethernet frames or one MTU-size Fiber Distributed Data Interface (FDDI) frame. It is important that you consider longer duration bursts when you specify the SCR.

When large packets exceed the maximum transmission unit (MTU) of the link, it can be useful to send the entire packet as a burst. In these cases, you might want to specify an MBS that accommodates the entire packet.

There is no official definition of a burst. Think of a burst in terms of MTU-sized frames or whatever size frame the traffic pattern presents. This frame will then break down into some number of cells. To maximize the use of bursting, you should understand when you use the MBS and follow the recommendations for establishing its size.

PCR and SCR Configuration Guidelines

When specifying the PCR and SCR traffic parameters for nrt-VBR VCs, consider the following guidelines:

- PCR—Derive this rate in combination with MBS in order to achieve the desired latency for bursty traffic. Consider the PCR as a means of decreasing the latency of a VC rather than increasing its bandwidth.
- SCR—Specify this rate as though your traffic is constrained to it, as if it were a constant bit-rate circuit, and without concern for latency. In other words, consider SCR as the true bandwidth of the VC and not the long-term average rate.
- If you configure PCR=SCR, the burst calculation for MBS is ignored and the credit is set to 1, regardless of the burst size.



Note

Configuring nrt-VBR on a PVC with the PCR and SCR set to the same value, while lowering the transmit priority of the VC, provides equivalent real-time service class performance on the PA-A3 and PA-A6 ATM port adapters for CBR for data. However, Cisco IOS Release 12.2 introduces two new SAR priority levels to support proper prioritization for CBR and rt-VBR when competition for cell time slots arises. It also introduces the ability to configure CBR and rt-VBR at the command line, which makes the configuration of nrt-VBR to model a real-time service category unnecessary.

- Be sure that the router and the switch are basing their rate setting and policing on the same cell size. Some processors interpret rates based on 48-byte cells, and others use 53-byte cells. When implementing the PCR and SCR on ATM port adapters for Cisco Systems routers, the SAR processor accounts for the 5-byte ATM cell header, AAL5 padding, and an AAL5 trailer.
- When configuring multiple PVCs, be sure that the sum of the SCR values for all PVCs is less than the supported line rate.

Cisco ATM router interfaces do not support any Kbps values in the range from zero to the line rate. Instead, they support a set of incremental values.

It is important to be aware that the available values in Kbps include the bandwidth consumed by user data as well as by all ATM overhead, including the 5-byte cell header, cell padding, and AAL5 overhead.

When selecting PCR and SCR values, refer to [Table 5-7 on page 5-24](#) and [Table 5-8 on page 5-24](#), which describe the officially supported values for each interface hardware type.

Table 5-7 Supported Values for PCR, SCR, and MBS on the PA-A3 ATM Port Adapters

ATM Port Adapter	PCR and SCR	MBS
PA-A3-OC3	Supports increments of 4.57 Kbps	Supports increments of 1 cell
PA-A3-T3/E3	<ul style="list-style-type: none"> • For DS-3, supports increments of 1.33 Kbps • For E3, supports increments of 1.03 Kbps 	Supports increments of 1 cell

Table 5-8 Supported Values for PCR, SCR, and MBS on the PA-A6 ATM Port Adapters

ATM Port Adapter	PCR and SCR	MBS
PA-A6-OC3	Supports increments of 2.28 Kbps	Supports increments of 1 cell
PA-A6-T3/E3	<ul style="list-style-type: none"> • For DS-3, supports increments of 0.665 Kbps • For E3, supports increments of 0.515 Kbps 	Supports increments of 1 cell

Non-Real-Time VBR Configuration Examples

To configure a PVC for the nrt-VBR service category, use the **vbr-nrt** ATM VC configuration command. The following example configures a nrt-VBR PVC with a PCR of 55 MB, an SCR of 50 MB, and an MBS of 100 cells:

```
Router(config)# interface atm 5/0
Router(config-if)# pvc 1/200
Router(config-if-atm-vc)# ?
ATM virtual circuit configuration commands:
abr                Enter Available Bit Rate (pcr)(mcr)
broadcast          Pseudo-broadcast
cbr                Configure Constant Bit Rate (CBR) Service
class-vc           Configure default vc-class name
create             Configure VC Auto-creation Type
dbs                Dynamic Bandwidth Selection
default            Set a command to its defaults
dialer             set dialer pool this pvc belongs to
encapsulation      Select ATM Encapsulation for VC
```

exit-vc	Exit from ATM VC configuration mode
idle-timeout	Set idle time for disconnecting this SVC/AutoVC
ilmi	Configure ILMI management
inarp	Change the inverse arp timer on the PVC
ip addr inarp	Assign an ip address to the atm interface through ATMInarp
max-reserved-bandwidth	Maximum Reservable Bandwidth on a vc
no	Negate a command or set its defaults
oam	Configure oam parameters
oam-pvc	Send oam cells on this pvc
pppoe	PPPoE options
protocol	Map an upper layer protocol to this connection.
random-detect	Configure WRED
service-policy	Attach a policy-map to a VC
transmit-priority	set the transmit priority for this VC
tx-ring-limit	Configure PA level transmit ring limit
ubr	Configure Unspecified Bit Rate (UBR) for this interface
vbr-nrt	Enter Variable Bit Rate (pcr)(scr)(bcs)
vbr-rt	Enter Variable Bit Rate (pcr)(average)
vc-hold-queue	Configure hold queue size
vcci	VCC Identifier
vpn	Configure VPN parameters
Router(config-if-atm-vc)#	vbr-nrt 55000 50000 100

**Note**

You can also configure the **vbr-nrt** command as part of a VC class. For more information, see the “Configuring VC Classes” section on page 5-2.

MBS Configuration Example

The following example configures a PVC for nrt-VBR service with an MBS of 100 cells:

```
Router(config)# int atm 6/0.2
Router(config-subif)# pvc 1/100
Router(config-if-atm-vc)# vbr-nrt 55000 50000 ?
<1-65535> Maximum Burst Size(MBS) in Cells
Router(config-if-atm-vc)# vbr-nrt 55000 50000 100
```

Verifying a Burst

It can be tricky to detect a burst on an ATM VC.

It is important to understand that the ATM interface only bursts when the ATM VC has transmitted for a duration below the SCR. If the ATM VC has always transmitted at SCR, then no burst credits have accumulated and no bursting occurs.

To actually “see” a burst, we recommend using the following test procedure:

**Note**

You need a traffic generator and an ATM cell tester for this procedure.

- Step 1** Configure the PVC with a PCR that is two times the Kbps rate of the SCR.
- Step 2** Start the cell tester.
- Step 3** Start the traffic generator and transmit at a rate above the PCR.
- Step 4** On the cell tester, look at the measured intercell gap. The cell tester reports a smaller intercell gap, which indicates the burst.

- Step 5** Stop the cell tester and continue sending at PCR on the traffic generator.
- Step 6** Start the cell tester again. You will not see the burst. This is because the traffic generator has always sent cells above the PCR (and/or above the SCR). The ATM VC has never sent cells below the SCR and therefore has never accumulated enough credits to send above the SCR again.
-

When configuring the traffic shaping values for a nrt-VBR VC, factor any sustained bursts into the SCR. As illustrated with the test procedure above, the MBS is not designed for sustained transmission above the SCR.

Configuring the UBR Service Category on a PVC

UBR is intended for non-real-time applications that do not require any maximum bound on the transfer delay or on the cell loss ratio. It is a best-effort service category. UBR is typically used for data communications applications such as file transfer and e-mail. Other applications include fax transmission, Telnet, and LAN and remote office interconnections. Such applications are not sensitive to cell delay, but they are sensitive to cell loss.

ATM switches, such as the Cisco Catalyst 8500 series, allocate larger maximum per-VC queue limits for UBR PVCs. Queueing minimizes loss at the expense of greater delay.

Overview of the UBR Service Category

Neither an ATM-attached router nor an ATM switch provides traffic shaping or quality of service guarantees to a UBR VC. As a result, UBR VCs can experience a large number of cell drops or a high cell transfer delay as cells move from the source to the destination device.

The only traffic parameter that you can specify on a Cisco Systems router for UBR is the PCR. Some ATM switches do not enforce the PCR, and the value of PCR becomes informational only. On switched virtual circuits (SVCs) defined for UBR service, a router communicates to the network that a virtual circuit is configured for UBR by using the best effort indicator field in the ATM User Cell Rate Information Element (IE) of a signaling packet.

The PA-A3 and PA-A6 ATM port adapters allocate bandwidth based on the priorities of the PVCs. Each service category that is available on these ATM port adapters has a default transmission priority associated with it. For information on the default priorities, see the [“Default PVC Priorities”](#) section on page 5-29.

If an ATM port adapter supports multiple PVCs implementing different service categories, there are priorities in how the interface allocates bandwidth. An ATM port adapter first allocates bandwidth for the PCR of a CBR VC followed by AAL5 and AAL2 VoATM VCs. Next, the port adapter allocates bandwidth for the rt-VBR and nrt-VBR classes according to their PCRs and SCRs. Finally, the adapter allocates bandwidth for the MCR of the ABR VCs. Any remaining bandwidth is available for the VCs of the other service classes such as UBR. However, the amount of remaining bandwidth and when it appears is not guaranteed.

For more details about how the PA-A3 and PA-A6 ATM port adapters schedule cells, see the [“Scheduling on the PA-A3 and PA-A6 ATM Port Adapters”](#) section on page 2-29, the [“Collision Handling”](#) section on page 2-31, and the [“PVC Priorities”](#) section on page 2-35.

Advantages of UBR

The UBR service category provides the following advantages:

- Allows for a high degree of statistical multiplexing by not reserving any minimum bandwidth per VC. The VCs use the bandwidth up to the configured PCR when available.
- Models the best-effort service normally provided by the Internet. Best-effort service is suitable for applications tolerant to delay and not requiring real-time response.

Disadvantages of UBR

The UBR service category has the following disadvantages:

- The PCR only provides an indication of a physical bandwidth limitation within a VC.
- VCs of other ATM service categories have a higher transmission priority by the ATM port adapter's segmentation and reassembly (SAR) scheduler. When competition for a cell time slot arises, the scheduler will give the time slot to a VC of service classes with a higher priority.
- UBR does not place any bounds with respect to the cell loss ratio (CLR) or to the cell transfer delay (CTD). The end-system is expected to handle and adjust for any cell loss or cell delay.
- Retransmission occurs at higher layers because UBR does not guarantee cell delivery.

UBR Configuration Guidelines

If you configure a PVC without specifying any shaping parameters, the router implements a UBR PVC with a PCR equal to the line rate of the physical ATM interface.

UBR Configuration Example

To configure a PVC for the UBR service category, use the **ubr** ATM VC configuration command as shown in the following example:

```
Router(config)# interface atm 5/0
Router(config-if)# pvc 1/300
Router(config-if-atm-vc)# ubr 50000
```



Note

You can also configure the **ubr** command as part of a VC class. For more information, see the [“Configuring VC Classes” section on page 5-2](#).

Configuring the UBR+ Service Category—SVCs Only

Cisco Systems has developed a second UBR service category called UBR+, which implements the Minimum Cell Rate (MCR) traffic parameter for SVCs only.

UBR+ supports non-real-time applications that tolerate both high cell delay and cell loss on the network, but request a minimum guaranteed cell rate. As with the UBR service category, there are no network service-level guarantees for UBR+. However, the network can grant a service-level guarantee for the requested MCR.

Overview of the UBR+ Service Category

While UBR defines only an optional PCR traffic parameter, UBR+ adds the minimum cell rate (MCR) traffic parameter. On an ATM switch, UBR+ also defines a cell delay variation tolerance (CDVT).

It is important to understand that UBR+ implements MCR as a “soft guarantee” of minimum bandwidth. A router signals the MCR value at call setup time when creating a switched VC. It is up to the ATM switch to grant the bandwidth requested in the MCR parameter. In other words, a UBR+ VC is a UBR VC for which the MCR is signaled by the router and guaranteed by the ATM switch. Thus, UBR+ affects connection admission control and resource allocation on ATM switches.

In other words, UBR+ offers ATM interfaces the ability to communicate both the desired minimum and maximum cell rates to the ATM network. From a traffic shaping perspective, the SVC continues to be created as a standard UBR VC on the router.

Difference Between UBR+ and ATM Forum’s MDCR Implementation

UBR+ is a special ATM service category developed by Cisco Systems. A similar UBR service category is specified in an addendum to the ATM Forum Traffic Management specifications, which discusses implementation of an optional Minimum Desired Cell Rate (MDCR) parameter for the UBR service category.

However, the Cisco Systems and the ATM Forum implementation vary in how the minimum rate is signalled to the ATM network. Cisco Systems uses the existing MCR information element (IE) that is used by the ABR service category, but the parameter has a different interpretation. For UBR+, the MCR parameter represents a desired cell rate; but in ABR, the MCR specifies the lowest acceptable cell rate.

The ATM Forum does not use the MCR IE, but implements a new IE for the MDCR traffic parameter.

UBR+ Support on the PA-A3 and PA-A6 ATM Port Adapters

UBR+ is not applicable to PVCs. However, in releases prior to Cisco IOS Release 12.0(7)T, the command is still available within the CLI for PVC configuration—but it should not be used. If you apply a VC class with the **ubr+** command to a PVC, the Cisco IOS software assigns the UBR class to the PVCs. The router rejects a VC class on a PVC if the PCR and MCR defined in the **ubr+** command are higher than the line rate of the underlying physical interface.

UBR+ Configuration Guidelines

When configuring the UBR+ service category for SVCs, consider the following guidelines:

- The UBR+ service category is only applicable to SVCs on the PA-A3 and PA-A6 ATM port adapters. UBR+ is not supported on the PA-A1 or PA-A2 ATM port adapters.
- The **ubr+** command was introduced in Cisco IOS Release 11.3 T for SVCs on the PA-A3 ATM port adapter. In Cisco IOS Release 12.0(3)T, the **ubr+** command was enhanced to support configuration of UBR+ and configuration of output PCR and output MCR for VC bundles.
- You can optionally specify *input-pcr* and *input-mcr* parameters for a UBR+ SVC. You only need to specify the input parameters when your output and input parameters differ.
- If you omit the input parameters on the UBR+ SVC, the router automatically assigns the same values to these parameters as the output parameters.

UBR+ Configuration Example

To configure an SVC for the UBR+ service category, use the **ubr+** ATM VC configuration command as shown in the example. The following example specifies the *output-pcr*, *output-mcr*, *input-pcr*, and *input-mcr* arguments for an ATM SVC to be 10,000 Kbps, 3000 Kbps, 9000 Kbps, and 1000 Kbps, respectively:

```
Router(config)# interface atm 1/0
Router(config-if)# svc lion nsap 47.0091.81.000000.0040.0B0A.2501.ABC1.3333.3333.05
Router(config-if-atm-vc)# ubr+ 10000 3000 9000 1000
```

Configuring PVC Priorities

The PVC priority is used by the SAR scheduler to determine a transmission hierarchy when PVCs compete for the same scheduling time slot. When collisions occur, the SAR scheduler always gives the PVC with the higher priority precedence over a PVC of lower priority in the link list.

If you are experiencing a lot of collisions and need to increase the performance of a particular PVC, you can modify the default PVC priority. Remember that the transmit priority only affects the likelihood that the VC will be given priority access to a particular cell time slot. The transmit priority does not change the behavior of the SAR scheduler and does not implement a minimum bandwidth guarantee.

For more information about how the PVC priority affects collision handling by the SAR scheduler, see the [“Collision Handling” section on page 2-31](#) and [“PVC Priorities” section on page 2-35](#).

Default PVC Priorities

The ATM port adapter implements a default set of PVC priorities based upon the service category that you configure for the PVC. However, you can override the default priorities for a PVC using the **transmit-priority** command.



Note

Prior to Cisco IOS Release 12.2(4), the number of PVC priorities was four. The range of PVC priorities was increased from four to six priorities beginning in the following Cisco IOS software releases: 12.2(5), 12.2(14)S, 12.2(8)T, and 12.2(15)B.

As of Cisco IOS Release 12.2, the PA-A3 and PA-A6 ATM port adapters support the following default classes of PVC priorities:

- Priority 1—CBR, OAM cells, and signaling (Integrated Local Management Interface [ILMI], Q.2931 Signaling ATM Adaptation Layer [QSAAL])
- Priority 2—AAL5 or AAL2 VoATM VC (any service category)
- Priority 3—Real-time VBR
- Priority 4—Non-real-time VBR
- Priority 5—ABR
- Priority 6—UBR, UBR+

Transmit Priority Guidelines

When configuring the transmit priority, take care to avoid using a transmit priority of 1, which should be reserved for control traffic like OAM and signaling.

Changing the Default PVC Priority

To change the default transmit priority, use the **transmit-priority** command in ATM VC configuration mode as shown in the following example:

```
Router(config)# int atm 1/0.1
Router(config-subif)# pvc 0/100
Router(config-if-atm-vc)# transmit-priority ?
<1-6> priority level
Router(config-if-atm-vc)# transmit-priority 3
Router(config-if-atm-vc)# end
```

Verifying the PVC Priority

To verify the PVC priority, use the **show atm vc** privileged EXEC command. The following example displays a transmit priority of 3 for the PVC:

```
Router# show atm vc 1
ATM1/0.1:VCD:1, VPI:0, VCI:100
VBR-NRT, PeakRate:10000, Average Rate:5000, Burst Cells:0
AAL5-LLC/SNAP, etype:0x0, Flags:0x20, VCmode:0x0
OAM frequency:0 second(s)
InARP frequency:15 minutes(s)
Transmit priority 3
InPkts:0, OutPkts:0, InBytes:0, OutBytes:0
InProc:0, OutProc:0
InFast:0, OutFast:0, InAS:0, OutAS:0
InPktDrops:0, OutPktDrops:0
InByteDrops:0, OutByteDrops:0
CrcErrors:0, SarTimeOuts:0, OverSizedSDUs:0, LengthViolation:0, CPIErrors:0
Out CLP=1 Pkts:0
OAM cells received:0
OAM cells sent:0
Status:INACTIVE
```

Verifying Traffic Shaping Configuration

To verify the traffic shaping configuration on your PVC, use the **show atm vc** and **show interfaces atm** privileged EXEC commands. For more information about these commands, refer to the *Cisco IOS Wide-Area Networking Command Reference* publication.

Consider the following guidelines when interpreting the output from these commands:

- The shaping engine does not report the ATM cell header overhead, AAL5 padding, or the AAL5 trailer in the **show atm vc** or **show interfaces atm** command output fields.
- The shaping engine does not differentiate between actual data bytes and padding or filler payload. An ATM cell must contain 48 bytes in the payload field. An ATM interface uses two cells to transmit a 64-byte IP packet. In the second cell, “wasted” payload in the form of padding is counted by the ATM switch, but ignored by the router. Thus, unused cell payload can prevent the actual bit rate from reaching the SCR.

Understanding ATM and AAL Overhead

When using ATM, overhead to the payload data occurs in a couple of forms:

- ATM Layer overhead
- AAL Layer overhead

ATM Layer Overhead

ATM Layer overhead consists of the 5-byte (40-bit) cell header that is added to the 48-byte payload data to make a 53-byte cell. This ATM header is sometimes called the ATM cell “tax.” The ATM cell header is not included in the output of the **show atm vc** or **show interfaces atm** commands.

Figure 5-1 shows the parts of an ATM cell header.

Figure 5-1 Format of an ATM Cell Header

GFC 4	VPI 8	VCI 16	PT 3	CLP 1	HEC 8
32 bits					8 bits CRC

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AAL Overhead

The AAL provides additional information to the protocol data unit (PDU) payload to support the QoS needs of a particular ATM service category. The amount of overhead varies by the type of AAL being used. AAL5 is the most common type and its format is described in RFC 1483.

AAL5 adds the following types of overhead:

- 8-byte trailer
- 8-byte encapsulation header for Logical Link Control/Subnetwork Access Protocol (LLC/SNAP) (this is the default header for ATM PVCs on the Cisco 7200 series router)
- Variable amount of padding (up to 47 bytes) to make the AAL5 PDU an even 48-byte multiple.

The AAL overhead is not included in the output of the **show atm vc** or **show interfaces atm** commands.

Using the show atm vc Command

The **show atm vc** command provides information about your PVC configuration, including the service category, encapsulation, ring limits, and transmit priority.


Note

When you want to reference the VPI/VCI value, use the **show atm pvc** command.

The following example shows that the UBR service category has been configured with a PCR of 10000 Kbps for the PVC identified by virtual circuit descriptor (VCD) 2:

```
Router# show atm vc 2
VC 2 doesn't exist on interface ATM2/0
ATM5/0: VCD: 2, VPI: 1, VCI: 100
UBR, PeakRate: 10000
AAL5-LLC/SNAP, etype:0x0, Flags: 0x20, VCmode: 0x0
OAM frequency: 0 second(s)
PA TxRingLimit: 0 particles
PA Rx Limit: 0 particles
InARP frequency: 15 minutes(s)
Transmit priority 4
InPkts: 0, OutPkts: 0, InBytes: 0, OutBytes: 0
InProc: 0, OutProc: 0, Broadcasts: 0
InFast: 0, OutFast: 0, InAS: 0, OutAS: 0
InPktDrops: 0, OutPktDrops: 0
CrcErrors: 0, SarTimeOuts: 0, OverSizedSDUs: 0
OAM cells received: 0
OAM cells sent: 0
Status: ACTIVE
```


Note

The number of bytes reported in the OutBytes field does not include the size of the AAL5 trailer or padding, or ATM cell header.

Displaying the VCD of a PVC

To display the VCD of a PVC, use the **show atm pvc** privileged EXEC command:

```
Router# show atm pvc
```

Interface	VCD/ Name	VPI	VCI	Type	Encaps	Peak Kbps	Avg/Min Kbps	Burst Cells	Sts
2/0	1	0	5	PVC	SAAL	155000	155000		UP
2/0	2	0	16	PVC	ILMI	155000	155000		UP
2/0.2	101	0	50	PVC	SNAP	155000	155000		UP
2/0.2	102	0	60	PVC	SNAP	155000	155000		DOWN
2/0.2	104	0	80	PVC	SNAP	155000	155000		UP
2/0	hello	0	99	PVC	SNAP	1000			UP

Using the show interfaces atm Command

You can use the **show interfaces atm** privileged EXEC command to see several important values related to your ATM configuration and performance. The following statistics in particular provide some key information:

- Input and output rate in bits per second and packets per second (five minutes is the default period).
- Input and output queue size and the number of drops.
- Input error counters such as cyclic redundancy checks (CRCs), ignores, and no buffers.

The following sample output from a PA-A3 ATM port adapter shows that the port adapter has experienced 11,184 output queue drops since the counters were last cleared one week and one day ago:

```
Router# show interfaces atm 5/0/0
ATM5/0/0 is up, line protocol is up
Hardware is cyBus ENHANCED ATM PA
MTU 4470 bytes, sub MTU 4470, BW 149760 Kbit, DLY 80 usec, rely 255/255,
load 2/255
Encapsulation ATM, loopback not set, keepalive set (10 sec)
Encapsulation(s): AAL5 AAL3/4
4096 maximum active VCs, 7 current VCCs
VC idle disconnect time: 300 seconds
Last input never, output 00:00:00, output hang never

Last clearing of "show interface" counters 1w1d
Queueing strategy: fifo

Output queue 0/40, 11184 drops; input queue 0/150, 675 drops
5 minute input rate 1854000 bits/sec, 382 packets/sec
5 minute output rate 1368000 bits/sec, 376 packets/sec
155080012 packets input, 3430455270 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants
313 input errors, 313 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
157107224 packets output, 1159429109 bytes, 0 underruns
0 output errors, 0 collisions, 0 interface resets
0 output buffers copied, 0 interrupts, 0 failures
```



Note

The statistics do not include the size of the AAL5 trailer or padding, or ATM cell header.

Measuring Traffic Shaping Accuracy

To measure traffic shaping accuracy, we strongly recommend that you use an ATM traffic analyzer.

If you want to use the **show interfaces atm** output, we recommend that you translate the SCR that you configured into a packets-per-second unit of measure. Then, refer to the packets/sec field in the **show interfaces atm** command output. You might also notice that a larger packet size normally produces a bit rate that is closer to the configured SCR.

You should avoid using the 5 minute output rate field of the **show interfaces atm** command output, which is reported as an average bits-per-second rate based on a default load interval of 5 minutes. To be more reactive to short bursts of traffic, you can adjust the load interval down to a minimum of 30 seconds using the **load-interval** interface configuration command.

Related Documentation

The following table provides information about additional resources that you can read to learn more about some of the topics discussed in this chapter:

For more information about:	Refer to the following publications:
ATM technical standards	Approved ATM Forum Specifications
Configuring VCs and VC parameters	Cisco IOS Wide-Area Network Configuration Guide and Cisco IOS Wide-Area Network Command Reference
Configuring VC bundles	Cisco IOS Quality of Service Solutions Configuration Guide and Cisco IOS Quality of Service Solutions Command Reference
Configuring VC classes	Cisco IOS Wide-Area Network Configuration Guide Cisco IOS Quality of Service Solutions Configuration Guide and Cisco IOS Quality of Service Solutions Command Reference
Configuring VC ranges	Cisco IOS Wide-Area Network Configuration Guide and Cisco IOS Wide-Area Network Command Reference

Next Steps

This chapter provides detailed information and guidelines for you to configure traffic shaping on the PA-A3 and PA-A6 ATM port adapters. As we describe in [Chapter 2, “Cisco 7200 Series Architecture and Design for ATM Traffic Management,”](#) traffic shaping produces congestion on the router. Therefore, you need to manage your hardware and Layer 3 queues on the Cisco 7200 series router to optimize the complete flow of ATM traffic.

You can find information about configuring Layer 3 queues on the Cisco 7200 series routers in [Chapter 6, “Configuring QoS on the Layer 3 Queues for the PA-A3 and PA-A6 ATM Port Adapters.”](#)

[Chapter 7, “Configuring the Ring Limits on the PA-A3 and PA-A6 ATM Port Adapters”](#) provides information about optimizing the hardware queues on the PA-A3 and PA-A6 ATM port adapters.